INDIANA'S GENETIC TREE IMPROVEMENT PROGRAM

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Abstract.--The Indiana Division of Forestry has an active tree improve-ment program. Initial efforts at genetic improvement were made in the 1970's, but the last three years have seen the greatest expansion of activities. The program is thoroughly established, is ongoing, and is showing results. It is a practical application of the knowledge gained through forest genetics research.

Black walnut and tulip tree are the principal species being improved. Virginia pine, American chestnut, cottonwood, and white oak are being worked with to a lesser extent. Total seed orchard area is approaching 100 acres.

Selection and progeny testing are continuing activities. Seed orchards are predominately clonal. Many methods of vegetative propagation are used.

The program strives to place genetic improvement into the seedlings distributed for reforestation by our nurseries.

Additional keywords: Grafting, progeny testing, selection, *J. nigra*, *L. tulipifera*, *P. virginiana*, *C. dentata*.

INTRODUCTION

The Indiana Division of Forestry considers the genetic improvement of our forest-tree species to be an important part of the total reforestation effort. And pursuant to this viewpoint, the past decade has seen an expansion of planned genetics activities leading to the present program described in this report.

During the 1960's, genetic improvement was planned and initial efforts made by the Division of Forestry. These early efforts included seedling black walnut (*Juglans nigra* L.) orchards at our nurseries, walnut rootstock outplantings, and locating superior tree selections of several species.

In 1970, a Tree-Improvement Specialist was employed on a part-time basis, a program written, and work started on a major genetics effort. In 1973, the Tree-Improvement Specialist was placed on full-time genetics work and the program was revised, updated, and expanded. Today, we are performing genetics work on black walnut, tulip tree (*Liriodendron tulipifera* L.), Virginia pine (*Pinus virginiana* Mill.), American chestnut (*Castanea dentata* Marsh.), cottonwood (*Populus deltoides* Bartr.), and white oak (*Quercus alba* L.). Major emphasis at this time is on black walnut and tulip tree.

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Our program is basically clonal. The overall approach is to select Individual trees within a species, enter them into a program of progeny and clonal tests, and graft (or otherwise vegetatively propagate) the better individuals into seed orchards. The program is of a practical nature and endeavors to take the information yielded by workers in forest genetics research and apply it to get genetic improvement into the seedlings distributed by our two nurseries.

The remainder of this report describes the procedures, facilities, and present status of our genetics program.

SELECTION

Two basic guidelines are used in selecting superior tree candidates. 1) an individual tree must meet certain pre-determined standards in phenotype. 2) Large numbers of trees are selected and tested to provide better chances of finding superiority and irregular traits beneficial to our program.

Selection is implemented and accelerated by utilizing Service Foresters, Property Foresters, and other divisions (Park, Nature Preserves, etc.), outside agencies, and private individuals. Through training sessions and publications, people become aware of the type of trees being sought. This system has worked well and the above individuals and organizations have located many trees for inspection as superior tree candidates.

The Division of Forestry initiated a selection program for tulip tree two years ago. To date, 41 tulip trees have been selected and are now undergoing genetic testing. Fourteen Virginia pine selections have been made in southern Indiana. Also, other Virginia pine selections were received from the U.S. Forest Service. These were tested clones received as bench-grafted trees in 1971.

American chestnut selections are sought on a regular basis for inclusion in our program to find genetic blight resistance.

Cottonwood selections have been received from the Missouri Department of Conservation, the U.S.F.S. (Stoneville, Mississippi), and the University of Illinois. We have made a few cottonwood selections within the state.

Selection of black walnut is done in cooperation with Purdue University (Beineke and Lowe, 1969). The Purdue Black Walnut Genetics research project has greatly aided our efforts and has allowed the program with this species to expand at a rapid rate. To date, we are grafting over 40 walnut selections whose genetic worth has been ascertained by previous testing.

Selection is a continuing process within the Division. A superior tree register is maintained for species slated for future genetic investigation.

PROGENY TESTING

Previously, we relied on other organizations to provide testing of families and clones. In September, 1974, however, we began a formal half-sib progeny testing program with black walnut, tulip tree, and other species. The nursery phase of our testing is performed mostly at the Vallonia Nursery in Southern Indiana (Jackson County) and tests have been sown every year since 1974.

The black walnut progeny tests are done jointly with Purdue, with our facilities being utilized for seedling production and outplantings and the universities facilities being utilized for genetic evaluation of sources. These cooperative arrangements we believe to be mutually beneficial and helpful in avoiding duplication of effort.

In 1974, 85 walnut families, 15 tulip tree families, a pine hybrid, 7 cottonwood clones, and numerous American chestnut families were progeny tested at the Vallonia Nursery. In 1975, 81 walnut families, 25 tulip tree families, 18 cottonwood clones, and several American chestnut families were tested and are now growing in the nursery.

The 1974 test was lifted in March, 1976 and outplanted into 3 walnut progeny tests, 4 tulip tree progeny tests, and 1 chestnut outplanting. In addition, a white ash provenance study was received from the U.S. Forest Service and planted at that time. Table 1 and the map in Figure 1 show the locations and sizes of these various outplantings.

Table 1.--Progeny test outplantings, Indiana Division of Forestry, 1976.

Test	Species	Size	Character	County
Harrison '74	B. Walnut	1 A	Half & Full-Sib	Harrison
Harrison '75	B. Walnut	3 A	Half & Full-Sib	Harrison
Mississenawa	B. Walnut	1 A	Half & Full-Sib	Wabash
Harrison '75	Tulip Tree	3 A	Half-Sib	Harrison
SIPAC '75	Tulip Tree	2 A	Half-Sib	Dubois
Maumee USFS '75	Tulip Tree	1 A	Half-Sib	Jackson
Wayne USFS '75	Tulip Tree	1 A	Half-Sib	State of Ohio
Harrison Hyb.	"Pitchlob"	1 A	--	Harrison
SIPAC Hyb.	"Pitchlob"	1 A	--	Dubois
J.P.	Cottonwood	1 A	Clonal	Pulaski
Vallonia	Cottonwood	1 A	Clonal	Jackson
Martell P.U. '75	B. Walnut	1 A	Half & Full-Sib	Tippecanoe
Harrison,'75	White Ash	4 A	Half-Sib	Harrison

Progeny testing has been performed with a system using five replications in the nursery, 5 replications in the outplantings, and randomization within the replications. Single-tree plots have been used regularly in the outplantings. Efforts are made to utilize uniform nursery and outplanting sites. Checks consist of randomly selected seeds from the nursery production seed lots. Families are measured and evaluated for all traits deemed beneficial for a forest tree and detailed records are maintained. Numerous families have shown definite superiority and several unusual traits have been isolated.

Many of these tests are being outplanted onto our State Forest properties where they will also serve as reforestation plantings. They can, of course, be used as seedling orchards to eventually supplement the seed production from our clonal orchards.

SEED ORCHARDS

The locating, development, and care of seed orchards has, and still is, consuming most of the time put into the tree improvement program of the Indiana Division of Forestry.

Total area being developed for seed orchards is rapidly approaching 100 acres.

We have decided to bypass seed production areas and other interim solutions and go directly to production orchards. Most orchards are clonal and this has necessitated developing and using a variety of grafting techniques.

With black walnut, field grafting was used in the initial years. Later, some success was obtained with various budding techniques. The greatest grafting success, however, has been realized from greenhouse bench-grafting techniques (Masters and Beineke, 1972). This method involves using dormant scion, and seedling rootstocks just breaking dormancy. The grafting is done in the Spring. The stocks are grafted bare root using a cleft or side graft which is wrapped and waxed. The grafted tree is then potted into a 1 gallon paper milk carton and placed in the greenhouse until the scion shoot is 6" to 10" in length (takes 4-6 weeks), then planted directly into the seed orchard. This method has given 50-85% "takes" consistently and has also worked with tulip trees.

Construction of a 22' x 60' fibreglass greenhouse for bench-grafting has just been completed at our Vallonia Nursery. This house should have the potential of producing 1000 + grafted trees per year.

Budding has been used for tulip tree with some success. Rooting has not been tried with any species. Virginia pine grafting has been done in the orchard on established stocks using a side graft. Success with pine grafting has been good.

Table 2 is a listing of seed orchards, and it should be noted that the orchards listed are in various stages of development. For instance, the 20

acre Mitchell Black Walnut orchard is about 50% complete; that is, about ½ of the spaces contain a grafted tree, the Atterbury orchard was established two years ago and is about 1/5 filled (300 grafted trees), the Virginia pine orchard is about 80% grafted, etc.

Table 2.--Seed orchards, Indiana Division of Forestry, 1976.

Name	Species	Size	Character	County
Mitchell	B. Walnut	20 A	Grafted	Lawrence
Atterbury	B. Walnut	30 A	Grafted	Johnson
J.P. #1	B. Walnut	1 A	Grafted	Pulaski
J.P. #2	B. Walnut	5 A	Grafted	Pulaski
Vallonia	B. Walnut	2 A	Grafted & Seedling	Jackson
J.P.	B. Walnut	2 A	Seedling	Pulaski
Kingsbury	B. Walnut	10 A	Grafted	LaPorte
Vallonia VP	Virginia Pine	5 A	Grafted	Jackson
Vallonia	Amer. Chestn.	3 A	Seedling	Jackson
Vallonia TT	Tulip Tree	6 A	Grafted	Jackson
Vallonia CC	Chin. Chestn.	3 A	Seedling	Jackson
J.P.	B. Walnut	1 A	Seedling	Pulaski

Currently, seed is being produced in the Mitchell Black Walnut, J. P. Seedling Black Walnut, Vallonia Black Walnut, Vallonia Virginia Pine, Vallonia American Chestnut, and Vallonia Chinese Chestnut orchards. This seed production is in small quantities presently, except for the chestnut orchards which produce heavy crops.

The map in Figure 1 depicts locations of our seed orchards.

CONCLUSIONS AND FUTURE PLANS

We feel that our forest tree improvement program is now a viable one which will eventually give a substantial genetic gain for the more important species. The privilege of collecting seed from orchard areas instead of wild stands would, in itself, be a welcome change and cultural orchard treatments are being instituted to hasten full seed production.

The overall plan is to continue selection, testing, and orchard establishment with two species at a time. Black walnut and tulip tree are the first species to be completed. As orchards begin producing seed, second generation breeding and testing techniques are being investigated and implemented.

INDIANA

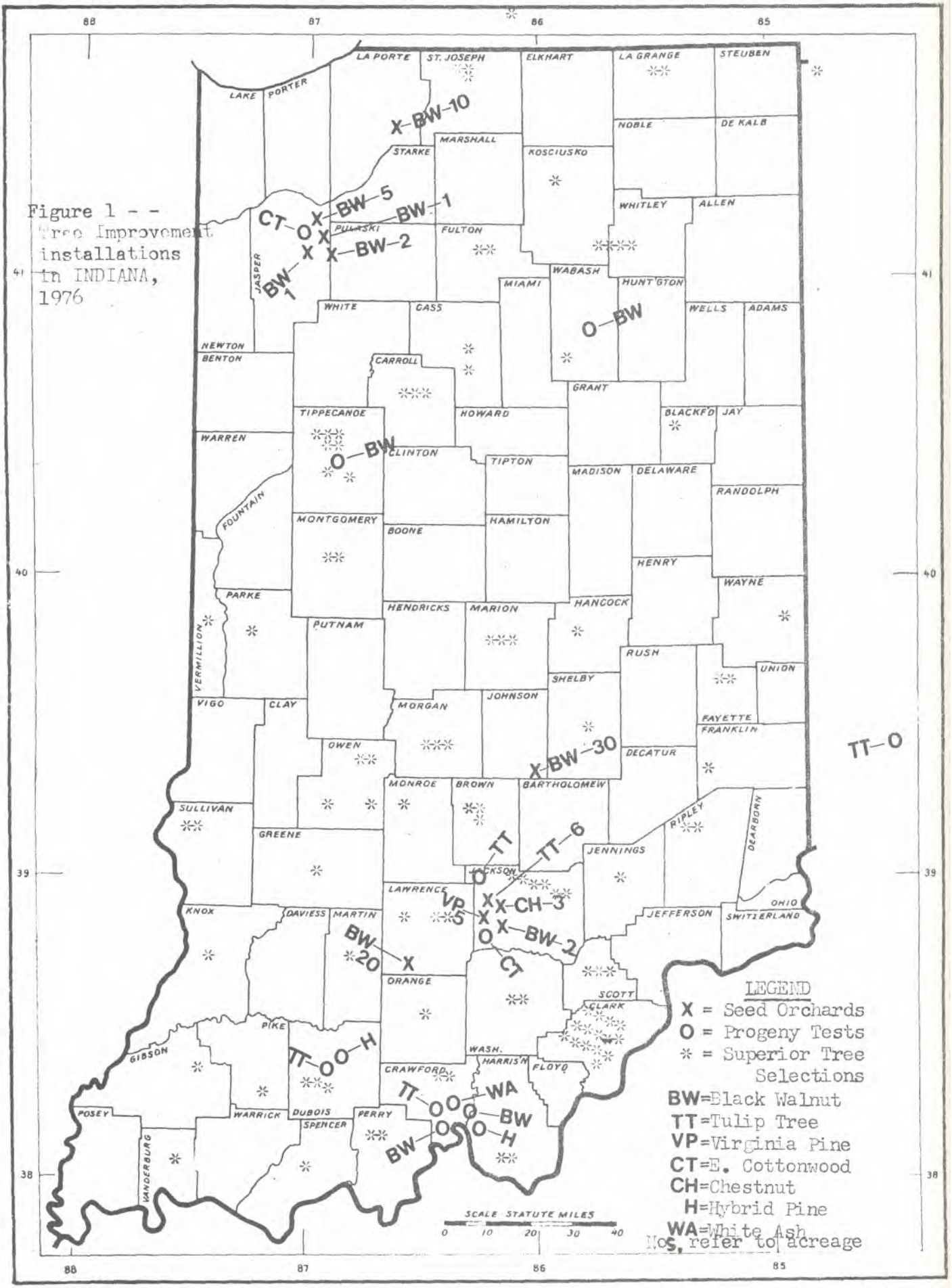

Figure 1 - - Tree Improvement installations in INDIANA, 1976

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Indiana's forest industries produce some of the world's finest hardwood products. Our forests are a major resource. We feel that genetic improvement of the more important species will enhance this resource by preserving the best genotypes and producing seedlings which give optimum performance in reforestation plantings.

LITERATURE CITED

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